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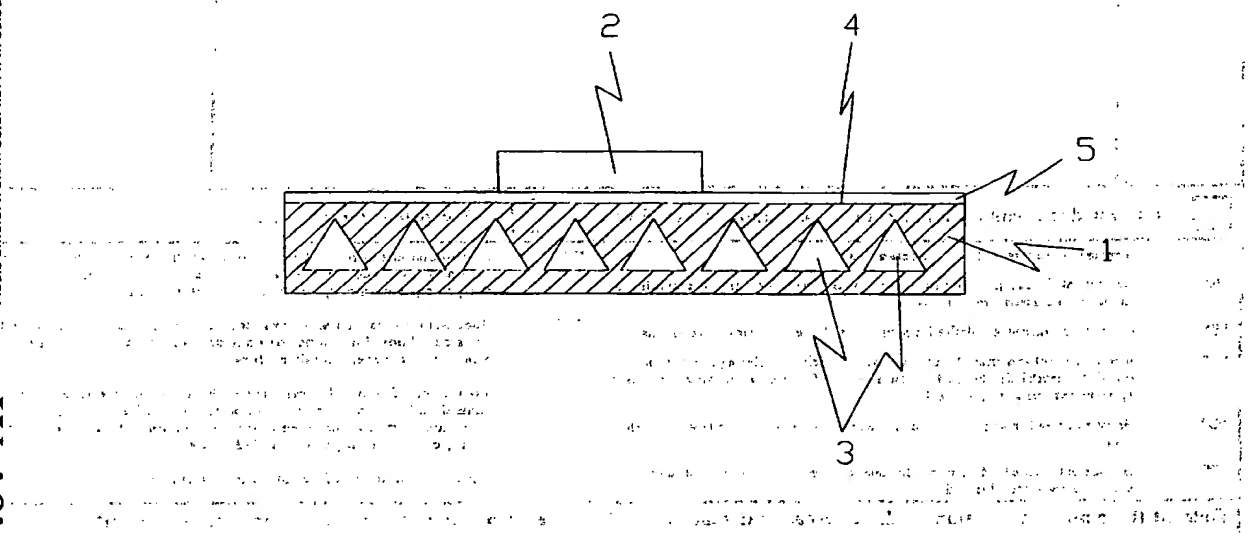
(54) Title: METHOD OF INSTALLING HEAT SOURCE, AND MICRO HEAT PIPE MODULE



(57) Abstract: The invention relates to a method of installing a heat source generating thermal energy on a micro heat pipe module and to a micro heat pipe module. The micro heat pipe module (1) has micro heat pipes (3) for dissipating the thermal energy generated by the heat source (2) generating thermal energy, and the micro heat pipe module (1) has a side (4) on which the heat source (2) generating thermal energy is installed. The side (4) of the micro heat pipe module (1), on which the heat source (2) generating thermal energy is installed, is at least partly coated with a coating (5) made of a heat conducting material, which coating (5) is arranged to conduct the heat generated by the heat source (2) generating thermal energy away from the heat source (2) generating thermal energy along said side (4) of the micro heat pipe module (1) and to the micro heat pipe module (1).

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METHOD OF INSTALLING HEAT SOURCE, AND MICRO HEAT PIPE MODULE

BACKGROUND OF THE INVENTION

The invention relates to a method of installing a heat source generating thermal energy on a micro heat pipe module which comprises micro heat pipes for dissipating thermal energy generated by the heat source, in which method the heat source generating thermal energy is installed on one side of the micro heat pipe module.

The invention also relates to a micro heat pipe module which comprises micro heat pipes for dissipating thermal energy generated by a heat source and which micro heat pipe module has a side on which the heat source generating thermal energy is installed.

Cooling electronic components is an old problem which has become more and more pronounced with increasing integration intensities and power. New methods, such as heat pipes, have lately emerged along with conventional convection cooling. A standard heat pipe is typically a copper cylinder several millimetres in diameter and about nine inches in length, emptied of air and partly filled with a working fluid.

A heat pipe conducts thermal energy generated by a heat source, such as an electronic component, from one end of the heat pipe to another as latent heat from the change of phase of a working fluid in the heat pipe. The thermal heat generated by the heat source makes the working fluid boil and vaporise in the hot end of the heat pipe, i.e. the vaporiser of the heat pipe. Due to a generated pressure difference, the vapour moves to the other, cold end of the heat pipe, i.e. the condenser of the heat pipe, where the vapour surrenders it latent heat and returns as fluid back to the vaporiser driven by capillary forces. A heat pipe is an extremely efficient heat conductor, its effective thermal conductivity is typically 10 to 100 times better than that of copper.

Until now, heat pipes have usually been installed in such a manner that for each heat source, such as an electronic component, there is one separate heat pipe conducting heat to a condenser. If one circuit board has several electronic components requiring cooling, placing heat pipes in an efficient manner is difficult, awkward and requires space.

This problem has been solved by means of micro heat pipe modules which comprise very small micro heat pipes placed side by side and a binding agent. These have been used to even out temperature distribution, especially when the heat source is a local one and surrounded by an area considerably cooler in temperature. The micro heat pipe modules are usually attached between the heat source, such as an electronic component generating thermal energy, and another surface, such as a circuit board, cooling plates or the body of an apparatus. Micro heat pipe modules have been disclosed in US patent 5,527,588, for instance.

The method has its limitations, however. A micro heat pipe module has a limited heat conducting ability. When a local heat load increases too much at a heat source, the micro heat pipes cannot function due to a partial drying up, for instance. In such a case, the internal pressure of a micro heat pipe beneath a heat source, such as an electronic component, increases too much and fluid cannot for some reason return to the vaporisation area driven by capillary forces. There are also several other reasons which may stop the heat pipes from functioning. They all have in common that there is too high a local heat load at a heat source, and if the heat source is an electronic component, the result often is that it is destroyed.

BRIEF DESCRIPTION OF THE INVENTION

It is thus an object of the invention to develop a method of installing a heat source generating thermal energy on a micro heat pipe module and a micro heat pipe module so as to solve the above problems.

The object of the invention is achieved by a method characterized in that the side of the micro heat pipe module, on which a heat source generating thermal energy is installed, is coated at least partly with a coating made of a heat conducting material, which coating is arranged to conduct the heat generated by the heat-generating heat source away from the heat-generating heat source along said side of the micro heat pipe module and into the micro heat pipe module.

Preferred embodiments of the method of the invention are set forth in the dependent claims 2 and 3.

An arrangement of the invention is in a corresponding manner characterized in that the side of the micro heat pipe module, on which the heat-generating heat source is installed, is at least partly coated with a coating

made of a heat conducting material, which coating is arranged to conduct the heat generated by the heat-generating heat source away from the heat-generating heat source along said side of the micro heat pipe module and into the micro heat pipe module.

Preferred embodiments of the arrangement of the invention are set forth in the dependent claims 5 to 9.

The solution of the invention increases the maximum power transmission capacity of a micro heat pipe module by reducing the local heat load at the heat source.

The solution is based on the use of a coating, i.e. more exactly a thermal pre-levelling material. When thermal energy generated by the heat source diffuses along the pre-levelling layer in lateral direction, the local heat load on the top surface of the micro heat pipe module at the heat source decreases and the micro heat pipe module can function longer at a higher component power before a local operational limit is reached.

The coating can also act as a galvanic insulation layer, and it can be machined, if necessary.

In addition, it is possible to use a more extensive material selection, such as plastics, as the cold surface in connection with the solution of the invention.

BRIEF DESCRIPTION OF THE FIGURES

In the following, the invention will be described by means of preferred embodiments and with reference to the attached drawing which shows a side view schematic of a micro heat pipe module of the invention.

DETAILED DESCRIPTION OF THE INVENTION

The figure shows a micro heat pipe module 1 which comprises micro heat pipes 3 for dissipating thermal energy generated by a heat source 2, such as an electronic component. The operation of such a micro heat pipe 3 is known per se and is, therefore, not described herein in more detail.

The micro heat pipe module 1 has a side 4 on which the heat source 2 generating thermal energy is installed. The figure shows a micro heat pipe module 1 in the shape of a rectangular prism, having six sides, of which at least one is intended for the heat source 2 generating thermal energy.

The side 4 of the micro heat pipe module 1, on which the heat source 2 generating thermal energy is installed, is at least partly coated with a coating 5.

The coating 5 is made of a heat conducting material.

The coating 5 is arranged to conduct the heat generated by the heat source 2 generating thermal energy away from the heat source 2 generating thermal energy along said side 4 of the micro heat pipe module 1 and to the micro heat pipe module 1. The coating 5 is thus arranged to distribute thermal energy from the heat source 2 to a wider area and consequently, the local heat load peak at the heat source 2 and in its immediate vicinity becomes smaller. Due to the distribution of the heat load from the heat source 2 generating thermal energy by means of the coating 5 to a wider area and on therefrom to the micro heat pipe module 1, the micro heat pipe module 1 is able to function longer at a higher component power before reaching a local operational limit.

The side 4 of the micro heat pipe module 1, on which the heat source 2 generating thermal energy is installed, is preferably substantially completely coated with the coating 5.

The heat source 2 generating thermal energy is preferably installed on the coating 5 as shown in the figure.

Several heat conducting materials can be used as the coating 5, and several coating techniques are possible.

The heat conducting material of the coating 5 preferably comprises metal, preferably copper metal. Copper and copper metals are known for their good heat conductivity. A electrically conductive plane can be formed with a copper metal or another metal on the surface of the micro heat pipe module 1, and the heat source 2 can be directly grounded to it. It is also easy to solder the heat source 2 to a copper metal, which provides an excellent heat conductivity and ground conductivity.

The coating 5 can preferably comprise graphite or diamond-like carbon.

The coating 5 can also act as a galvanic insulation layer which insulates various electronic components from each other and/or from the micro heat pipe module 1 so that electrical current cannot flow from one electronic component to another.

The invention also relates to a method of installing a heat source 2 generating thermal energy on a micro heat pipe module 1 which comprises micro heat pipes 3 for dissipating the thermal energy generated by the heat source 2.

In the method, a heat source 2 generating thermal energy is installed on one side 4 of a micro heat pipe module 1.

In the method said side 4 of the micro heat pipe module 1, on which the heat source 2 generating thermal energy is installed, is at least partly coated with a coating 5 made of a heat conducting material. The coating 5 is arranged to conduct the heat generated by the heat-generating heat source 2 away from the heat-generating heat source 2 along said side 4 of the micro heat pipe module 1 and to the micro heat pipe module 1.

Said side 4 is preferably coated substantially completely.

The heat source 2 generating thermal energy is preferably installed on the coating 5.

It is obvious to a person skilled in the art that while technology advances, the basic idea of the invention can be implemented in many different ways. The invention and its embodiments are thus not restricted to the examples described above, but can vary within the scope of the claims.

CLAIMS

1. A method of installing a heat source (2) generating thermal energy on a micro heat pipe module (1) which comprises micro heat pipes (3) for dissipating the thermal energy generated by the heat source (2), in which method

a heat source (2) generating thermal energy is installed on one side (4) of the micro heat pipe module (1),

characterized by

coating at least partly the side (4) of the micro heat pipe module (1), on which the heat source (2) generating thermal energy is installed, with a coating (5) made of a heat conducting material, which coating (5) is arranged to conduct the heat generated by the heat-generating heat source (2) away from the heat-generating heat source (2) along said side (4) of the micro heat pipe module (1) and to the micro heat pipe module (1).

2. A method as claimed in claim 1, **characterized** in that said side (4) is coated substantially completely.

3. A method as claimed in claim 1 or 2, **characterized** in that the heat source (2) generating thermal energy is installed on the coating (5).

4. A micro heat pipe module (1) which has micro heat pipes (3) for dissipating the thermal energy generated by the heat source (2) generating thermal energy, and which micro heat pipe module (1) has a side (4) on which the heat source (2) generating thermal energy is installed,

characterized in that

the side (4) of the micro heat pipe module (1), on which the heat source (2) generating thermal energy is installed, is at least partly coated with a coating (5) made of a heat conducting material, which coating (5) is arranged to conduct the heat generated by the heat-generating heat source (2) away from the heat-generating heat source (2) along said side (4) of the micro heat pipe module (1) and to the micro heat pipe module (1).

5. A micro heat pipe module as claimed in claim 4, **characterized** in that the side (4) of the micro heat pipe module (1), on which the heat source (2) generating thermal energy is installed, is substantially completely coated with the coating (5).

6. A micro heat pipe module as claimed in claim 4, **characterized** in that the coating (5) comprises metal, preferably copper.

7. A micro heat pipe module as claimed in claim 4, **characterized** in that the coating (5) comprises graphite.

8. A micro heat pipe module as claimed in claim 4, **characterized** in that the coating (5) comprises diamond-like carbon.

9. A micro heat pipe module as claimed in claim 4, **characterized** in that the heat source (2) generating thermal energy is installed on the coating (5).

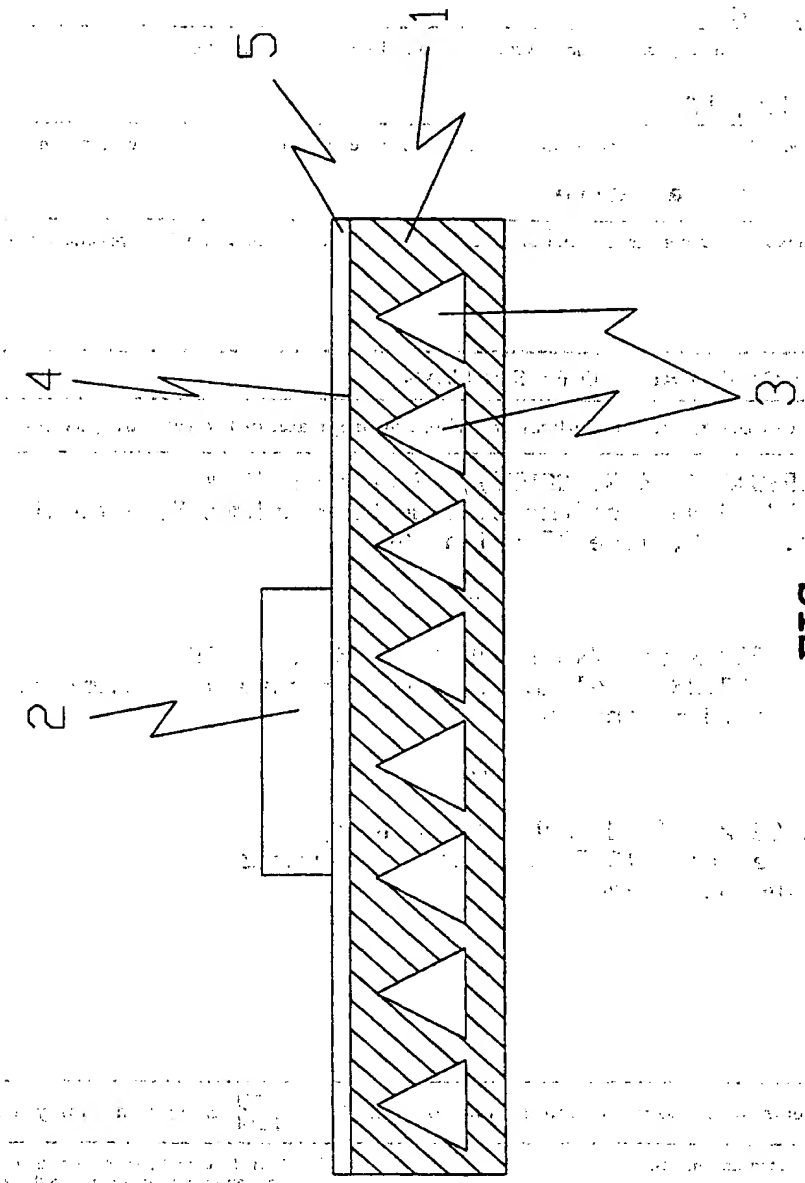

FIG.

INTERNATIONAL SEARCH REPORT

International application No.
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A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H05K 7/20, H01L 23/427
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H05K, H01L, F28D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5355942 A (A.S. CONTE), 18 October 1994 (18.10.94), column 2, line 50 - column 3, line 10; column 6, line 35 - line 64	1-9
A	US 5727619 A (A. YAO ET AL.), 17 March 1998 (17.03.98), column 2, line 10 - line 53; column 5, line 18 - line 24	1-9
A	US 5598632 A (C.J. CAMARDA ET AL.), 4 February 1997 (04.02.97), column 2, line 32 - line 62	1-0

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
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Date of the actual completion of the international search	Date of mailing of the international search report
13 October 2000	18 -10- 2000
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Antonio Farieta/AE Telephone No. +46 8 782 25 00

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International application No.
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 19849919 A1 (DUEWAG AG), 12 May 1999 (12.05.99), column 1, line 3 - column 2, line 4 --	1-9
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INTERNATIONAL SEARCH REPORT

Information on patent family members

01/08/00

International application No.
PCT/FI 00/00596

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